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Determinants of Friendship in Social Networking Virtual Worlds

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Abstract:

This paper examines the determinants of friendship between two users in a virtual world who are unaware of each other's real identities. Drawing on theories of homophily, heterophily and propinquity, three virtual world behaviours are analysed: avatar appearance, avatar location, and avatar communication. Data are collected on 179 participants interacting in a novel virtual world. The main results show that: (1) avatars did not tend to form friendships with avatars that are similar in appearance to themselves but did tend to form friendships with avatars that are dressed differently from themselves; (2) in terms of location, the closer an avatar stands to other avatars, the more likely the avatar is to receive a friend invitation; and (3) the fewer words an avatar uses in communication, the more likely the avatar is to receive a friend invitation. This paper contributes to theories of virtual world interaction and to using virtual worlds as a data collection platform.

Keywords: avatar, server log, telemetry, online community, assortativity

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I. INTRODUCTION

A virtual world is a persistent, computer-mediated environment in which many users can synchronously interact [Bell, 2008]. Popular examples include World of Warcraft, EVE Online, and Ultima Online. The past decade has seen great interest in virtual worlds within the IS community [Wasko, Teigland, Leidner and Jarvenpaa, 2011; Davis, Murphy, Owens, Khazanchi and Zigurs, 2009; Schultze, Hiltz, Nardi, Rennecker and Stucky, 2008]. A user is represented in a virtual world by an avatar. Almost all virtual worlds include a facility for social networking, typically a friendship feature that allows users to connect with one another inside the world. Guest [2008] gives examples of friendships that form inside a virtual world in which the users do not know each other's identities, and know the other only as represented by his or her avatar. This may even be the norm rather than the exception. *The goal of this paper is to examine the determinants of friendships between avatars where the users are unaware of each other's real identities*.

Drawing on previous research into both real-world and online relationships, we examine avatar appearance, avatar location, and avatar communication. These three particular determinants of friendship are aspects of virtual-world behaviour that can be quantified, and are found in every virtual world we know of, unlike some other potential determinants of friendship. In terms of avatar appearance, the theories of homophily and heterophily—reviewed in the next section—suggest potential friendship determinants, which we then examine. *Homophily* is the tendency for people to associate with similar others. *Heterophily* is the reverse, in which relationships form between people who are dissimilar to one another. For avatar location we look at proximity—how close an avatar stands to others—and examine how this affects friendship: does how close an avatar stands next to others determine whether that avatar receives friend requests? For avatar communication we look at text-chat—specifically how talkative an avatar is—and examine how it affects friendship.

A knowledge of how virtual friendships are formed would feed into theories of virtual-world governance, information diffusion through a virtual world, and how users influence each other in the virtual world (for real world examples, see Ahuja [2000], Aral and Walker [2012], Dixit [2009], and Brass, Galaskiewicz, Greve and Tsai [2004]). This will become more important as the popularity of virtual worlds continues to grow: virtual-world user numbers are increasing [Wasko et al., 2011], as are revenues from virtual-world commerce [Sorom, 2010]. The number of worlds available also continues to rise, especially for use as gaming platforms but also as social networking spaces. Research interest remains too, with recent papers discussing the creation and design of the worlds [Roquilly, 2011; Chaturvedi, Dolk and Drnevich, 2011], the value of virtual worlds to individuals [Berente, Hansen, Pike and Batemen, 2011], the user-avatar relationship [Suh, Kim and Suh, 2011], and how users engage with the world [Nah, Eschenbrenner and DeWester, 2011; Goel, Johnson, Junglas and Ives, 2011].

The virtual world used here is controlled by the research team. This gives us access to the world's server logs and the detailed avatar telemetry contained within them. This telemetry includes all aspects of avatar design, the location of each avatar at all times, all avatar communication, and details of friendship invitations between avatars. The resulting dataset has data not only on friendships that formed but also on those that did not form, plus data on unrequited friendships in which an avatar was invited to form friendship but declined. This is not usually available to researchers studying relationships either in a real-world or online context, and it strengthens our results.

The paper proceeds as follows: Section II explains the concepts of homophily and heterophily in detail. Section III then discusses the importance of the avatar and reviews online homo-/heterophily research. The same section also reviews previous work on avatar location and avatar communication, which is currently more limited than the work on homo-/heterophily. Section IV describes the method we used to study avatar relationships. The remaining two sections present our results and discuss them.

Homophily and Heterophily

The theory of homophily states that people will tend to associate with similar others [Lazarsfeld and Merton, 1954]. These similarities could be based on age, gender, education level, race, or many other characteristics. Such associations have long been observed by sociologists [Moody, 2001] and have been used to explain such phenomena as social segregation [Currarini, Jackson and Pin, 2009] and social mobility [Lin, 1999]. Homophily is also an important concept in IS, having been used to explain information diffusion, technology adoption, and team

performance [Thelwall, 2009; Ruef, Aldrich and Carter, 2003; Hinds, Carley, Krackhardt and Wholey, 2000; McPherson, Smith-Lovin and Cook, 2001; Iribarren and Moro, 2011].

Theories explaining the origin of homophily tend to sit in one of two categories [Monge and Contractor, 2003]: similarity-attraction [Byrne, 1971] and self-categorisation [Turner, 1987]. Similarity-attraction posits that individuals seek consistency and select individuals similar to themselves to form relationships to provide this consistency. Self-categorisation suggests that individuals define themselves along dimensions such as age and race, and seek out others in the same category or categories to legitimise that identity. More recently however, some researchers [Ingram and Morris, 2007] have suggested that homophily results not from the choices of the individuals involved but from pre-existing "structures" that somehow tend to throw similar people together. An example of such a structure is the existence of a discount store that brings together people from the same socio-economic background.

The reverse of homophily is heterophily, where relationships are formed based on individual differences. The theory of heterophily, as in homophily, has been used to explain the diffusion of innovation [Rogers and Bhowmik, 1970] and communication effectiveness [Anderson and Alpert, 1974; Alpert and Anderson, 1973]. Recently it has been used in studies of word-of-mouth marketing [Nigam, 2012; Yamamoto and Matsumura, 2009]. Theories on the emergence of heterophily are less developed than theories of homophily [Benediktsson, 2012] and focus on diversity needed to achieve a goal [Rivera, Soderstrom and Uzzi, 2010] and the removal of social inhibition [Ingram and Morris, 2007]. An example of the first is the situation in which a sociologist forms a writing partnership with a statistician, as this is easier to do than learning statistics would be. An example of the second is a "networking party" where people try to make new business contacts. The removal of social inhibition may be particularly pertinent in online contexts such as virtual worlds, where reduced social cues theory suggests that communication is more "free," and social standards become less important [Kiesler, Seigel and McGuire, 1984]. This is because the attention of those involved in the communication is not split between the message and each other but is entirely focused on the message [Joinson, 2003].

Real-world studies have examined homophily and heterophily in age, sexuality, race, gender, income, education level, religion, status, and competence [Carley, 1991; Ibarra, 1993; Laumann, 1966; McPherson and Smith-Lovin, 1987]. They are, however, difficult to study. Benediktsson [2012] explains the situation as follows: "Understanding how cultural resources shape the formation of social networks is a methodological challenge as well as a theoretical objective, and both are yet to be met" (p. 46). He goes on to discuss the role of homophily and heterophily in the formation of social ties, stating that heterophily especially is untheorised by sociologists in spite of it being of key interest. He highlights one reason for this: the difficulty of collecting data—something that, as fully explained later, is overcome in a virtual-world setting. The next section presents theory relating to avatar-mediated interaction inside a virtual world, in particular avatar appearance, movement, and communication.

II. AVATAR

A virtual world is different from other online communities such as blogging communities, social networks such as Facebook, and message board communities primarily because in a virtual world each user is represented by an avatar [Meadows, 2007]. Examples of avatars are shown in Figure 1. While many different types of online communities make use of something they refer to as an "avatar," a virtual-world avatar is different. A virtual-world avatar represents a user in real time. Modern examples are three-dimensional forms that navigate the virtual world as if they were walking through it (or running or flying, etc.). Many avatars take human form, and their developers attempt to re-create real-world human movement as accurately as possible. Theories explaining the relationship between user and avatar are complex, and it is generally believed that the existence of an avatar changes both the user's behaviour and how others respond to that user [Yee and Bailenson, 2007; Nowak and Rauh, 2006].

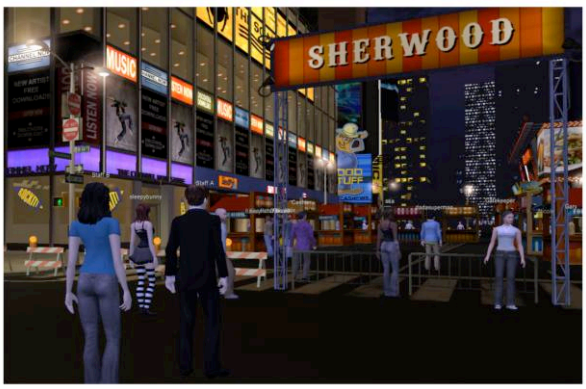

Figure 1. Avatars Interacting in a Virtual World

The avatar is fundamental to virtual worlds, and modern avatars exhibit an impressive range of characteristics and behaviours. Users are embodied through their avatars [Benford, Bowers, Fahlen, Greenhalgh and Snowden, 1995], self-representations that give a mechanism for communicating and interacting with other users and for navigating the world. The sense of presence users feel in the world tends to increase with avatar realism [Slater and Steed, 2009], and even basic avatars (in a graphical sense) have social significance [Slater, Sadagic, Usoh and Schroeder, 2000]. The design goal is to make users feel as if they are inhabiting a body rather than just operating an animated figure [Slater et al., 2000].

Research into real-world interactions has shown that people use their perceptions of another's visual appearance and behaviour to make social judgements and reduce uncertainty about who they are interacting with [Burgoon, Buller and Woodall, 1996; Clatterbuck, 1979; Infante, Rancer and Womack, 1997]. Research has also demonstrated that similar processes take place during computer-mediated communication, meaning that a user's avatar has an impact on how others perceive that user [Donath, 2007; Nowak and Rauh, 2006; Nowak, 2004; Yee and Bailenson, 2007; Taylor, 2002; Koda and Maes, 1996; Nowak and Blocca, 2003; Nass, Steuer, Tauber and Reeder, 1993]. People like to know something about those with whom they are interacting, and an avatar may be used as a proxy for the real person during interaction [Benford, Greenhalgh, Rodden and Pycock, 2001; Taylor, 2002; Talamo and Ligorio, 2001]. Even the physical appearance of the avatar may be transferred onto a user in the mind of the user who is interacting with him or her [Rauh, Polonsky and Buck, 2004]. This has implications for interpersonal relationships [Biocca, 1997; Biocca and Nowak, 2002; Schroeder, 1997, 2002]. In fact both Taylor [2002] and Bessiere, Seay and Kiesler [2007] suggest that a user sometimes chooses an avatar to represent what the user considers to be the essential elements of his or her identity, and therefore the avatar may be a better reflection of who the user really is than how he or she appears in the real world.

Thus the avatar is key to online identity [Taylor, 2003] and is often perceived as a "public signal" of whom the person is [Taylor, 2002]. It is the users' expression of themselves [Oravec, 1996], and users therefore prefer to have control over their avatars' appearance [Messinger, Ge, et al., 2008]. For this reason, virtual-world designers often give users the ability to customise their avatars. A number of researchers have observed homophily between users and their avatars: both Messinger, Ge, et al. [2008] and Bessiere et al. [2007] find that some users customise their avatars to bear similarity to their real selves. Homophily between users and their avatars is of course distinct from homophily between one avatar and another avatar. Homophily between users and their avatars has received less attention in the literature. which.

The next subsection presents our dependent variable—virtual-world friendship—describing what it means and how it compares to both real-world friendship and friendship in other forms of online communication. Then three aspects of avatar interaction that may have an impact on friendship are examined: avatar appearance, avatar location, and avatar communication.

Virtual-World Friendship

Our dependent variable, explained fully in Section V, is virtual-world friendship, which we define as a user inviting another user to become friends by way of an in-world friendship feature, or a user accepting an offer of friendship from another user. Almost every virtual world has a friendship feature that allows users to network within the world. In World of Warcraft, for instance, friendship allows gamers to form groups to go on quests together [Chen, 2009; Williams et al., 2006]. In Second Life, the friendship allows users to easily communicate and collaborate on projects together [Andreas, Tsiatsos, Terzidou and Pomportis, 2010; Varvello and Voelker, 2010].

Virtual-world friendship captures the fact that a user is motivated to create a relationship with another user. It is, however, not the same as real-world friendship. Dreyfus [2004] sees the key difference as being the lack of a risk of humiliation. This is not entirely true: while it might be argued that there is less risk than in the real world, there is a very real danger of humiliation in a virtual world [Chesney, Coyne, Logan and Madden, 2009]. However, other differences have been suggested. Barney [2004] and Borgmann [2004] see the key difference as being a lack of physical practices. Virtual friends have no possibility of non-voluntary disclosure, which is seen as essential in "true" friendship [Cocking and Matthews, 2000; Rheingold, 2000]. An example of non-voluntary disclosure is blushing, which is not possible in a virtual world, at least not without a user making a conscience choice for his or her avatar to blush.

Munn [2012] argues convincingly that, while a virtual friendship might not equate to a real one, it is closer to a real friendship than friendships that form in other modes of online communication such as in chat rooms. The key point he makes is that a virtual friendship is based on shared *activity*, whereas other online experiences share only communication. For instance, real-world friends can go fishing together; virtual-world friends can go virtual-world fishing together; friends in a chat room can only text-chat with each other about going fishing.

There is some support for this view, and regardless of the lack of non-voluntary disclosure, virtual-world friendship can enhance well being, a key aspect of true friendship [Soraker, 2012]. Virtual friends can share experiences that increases positive emotions [Gable, Reis, Impett and Asher, 2004], and the fact that non-voluntary disclosure is not possible may in fact lead to an increase in voluntary disclosure, which tends to strengthen friendship [Briggle, 2008, Yee, 2006].

Avatar Appearance

Avatar appearance has previously been found to have an impact on friendship. For instance, Banakou [2010] finds that users with more elaborate avatars have higher success in their social encounters. *Elaborate* was defined by the amount of effort needed to create them. However, the elaborate avatars that these researchers used could be described in another light. The elaborate female avatar was dressed in very revealing clothes compared with the control female avatar that was used, and the elaborate male avatar was much more muscular. It may be these facts that led to their successful encounters rather than the effort put into designing them. The most likely way appearance affects friendship, however, is through homophily.

Previous studies have examined homophily in online communities, with support building for its existence [Bisgin, Agarwal and Xu, 2010; Crandall, Cosley, Huttenlocher, Kleinberg and Suri, 2008; Mislove, Viswanath, Gummadi and Druschel, 2010], meaning that community members tend to make friends with other community members that they are similar to in some way. For example, relationships in the online community MySpace show evidence that ethnicity, religion, age, country, and marital status are homophilious [Thelwall, 2009].

We might expect to find homophily or heterophily in the virtual world along any dimension found in the real world, as long as that dimension is implemented in the virtual world. We find support for this statement from the research highlighted previously and in Section II. The qualification that the dimension must be implemented is self evident—we would not expect to find age to be homophilious, for instance, if all avatars are implemented to appear to be the same age. (Recall that this study is of a situation where the real users are anonymous to each other, and therefore real-world age cannot be homophilious either.)

Thus when considering what might be homo- or heterophilious, we must consider what avatar characteristics can be customised by the user. In the world used in this study (explained in detail in Section IV), users are able to customise their avatar's name, gender, hairstyle, skin colour, clothing, and tattoos with a wide range of options for each. Each of these has been found to be homo- or heterophilious in the real world within certain contexts (see previous references plus Pyrooz, Decker and Fleisher [2011], Selfhout, Branje, Bogt and Meeus [2009], and McCullough, Giles and Thompson, [1985]); note that the finding about name homophily refers to surname). Apart from name, as the virtual world does not feature surnames, each of these will therefore be examined for homophily and heterophily in the virtual world. The avatar creation screen showing the options available is shown in Figure 2.

Figure 2. Customising an Avatar (The numbers beside each characteristic refer to the current selection and the number of options available. The *Room* option refers to the style of the avatar's apartment and is not a characteristic of the avatar.)

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Avatar Location

Influenced by social scientists such as Bossard [1932], Hall [1959], and Rubin [1978], who studied how the distance between people varies as they interact, virtual-world researchers have started to examine avatar proximity—how close avatars stand next to each other. In a small but growing body of work, studies have looked at a range of aspects of virtual-world personal space [Bailenson, Blascovich, Beall and Loomis, 2003; Nassiri, Powell and Moore, 2004; Wilcox, Allison, Elfassy and Grelik, 2006].

We know from real-world research that how closely people are located to others affects the formation of friendship. A basic theory is that being proximate encourages chance encounters and opportunities for interaction, which can lead to new relationships [Rivera et al., 2010]. One fact that limits the application of this theory in a virtual-world context is that the real-world research on which it is based looks at *living* proximity, which implies a longer-term proximity than avatars standing beside each other in a room for a short time. Nevertheless, avatar proximity clearly has an effect. The proximity among interacting avatars is not arbitrary [Friedman, Steed and Slater, 2007], and there is some evidence that users prefer to keep their avatar closer to other avatars of the same race [Dotsch and Wigboldus, 2008; Wallace and Maryott, 2009]. This suggests that proximity may have an impact on avatar friendship but does not allow for an explicit prediction of what that impact will be on friendship.

Avatar Communication

Studies into virtual-world communication and into the wider range of computer-mediated communication often offer up contradictory results, suggesting that online communication is much more complex than it might at first appear. Early work suggests that computer-mediated communication is impersonal and potentially hostile [Kiesler et al., 1984], something not supported in many follow-up studies [Rice and Love, 1987].

To try to reconcile this, Walther [1992] proposed the social information processing theory and followed this up with the hyperpersonal model [Walther, 1996].. Both of these theories can be used to explain how text-based avatar chat might lead to a friendship that is as close as a relationship that could be achieved from audio-based avatar chat or from a video conference between two users, or even from a face-to-face meeting. The essence of both theories is that as the length of time over which communication happens increases, the exchange of social information increases, which in turn means that strong relationships can form. So while a face-to-face meeting or an audio-only meeting can result in friendship more quickly, text-based communication can eventually achieve or exceed the intimacy that can be achieved via these other media. However, neither theory offers predictions on how text-chat within a group of avatars might have an impact on whether friendships form. Intuition would suggest that more text-chat between avatars might increase the likelihood of friendship, but this has not previously been tested. The next section presents our method for data collection in the virtual world.

III. METHOD

This section describes the virtual world that was used in this study and the data collection procedure. The next section then discusses the resulting dataset in detail.

The genesis of the virtual world lies in computer games and military research [Schroeder, 1997; Messinger, Stroulia and Lyons, 2008] and many virtual worlds remain multiplayer computer games. World of Warcraft and Star Wars: The Old Republic are examples. These games are built around quests—missions that the users are given by the games' creators. Other worlds have emerged as social networking spaces, where users are not given explicit goals. Second Life is typical of these. Second Life is difficult to classify as a game [Schultze and Rennecker, 2007] and is better described as an "arena of creativity" [Chesney et al., 2009] or a virtual 'place' rather than a game [Turkle, 2011], a place where sometimes work as well as play gets done [Terdiman, 2007]. We refer to these as social networking virtual worlds.

The virtual world used in this study is such a world. Called Places/Sherwood, it was developed by software house Multiverse (see www.multiverse.net) and is similar in appearance to Second Life. It was constructed for a larger project [Dieterle and Murray, 2010] of which this study is a part, and we controlled all user accounts so that only our participants could access it. The world's asthetic is modern-day New York. The main area is a re-creation of Times Square, and each avatar has his or her own private apartment. The world allows text-chat and a range of avatar gestures but no audio. Avatars can explore by walking (no running, jumping, or flying) and can invite other avatars to be their friends. Friends can communicate privately with each other and can visit each other's apartments. For the friendship to form, the invited avatar must agree to it.

Participants were drawn from a young (aged 18–25), computer-literate population that had a high school diploma or college degree. Using standard recruitment procedures from experimental economics and applied psychology [Kagel and Roth, 1995], we contacted representative groups from this population, such as university social societies,

and invited them to take part. Those who agreed were randomly assigned to a data collection session in a computer lab. A total of 179 participants took part in one of 20 sessions with between 8 and 12 participants in each. Prior to attending the session, participants completed an online questionnaire to capture demographics on gender, age, and computer game experience. Upon arrival at the lab, participants were randomly seated and asked to read and sign an informed-consent document. Sessions were then held in silence, and players were positioned so that they could not clearly see each other's screens, although participants were encouraged to interact with each other inside the world. Participants were logged into a fresh account that took them to the avatar creation screen. They could then customise the gender, clothing, hairstyle, hair colour, and skin colour of their avatars.

Avatars initially appeared alone in their apartments, where participants could become familiar with the interface controls (on-screen instructions were given). No real-world announcements were made after participants were logged in, although two researchers were in-world and made announcements from there. Avatars were asked to come to Times Square to explore the world and play an ice-breaker game designed to encourage socialisation. Participants stayed in the virtual world for about 90 minutes. Sessions took place at two physical locations: one in the UK and one in Dubai. Participants were paid 5GBP (or the UAE dirham equivalent) for attending. Of the 179 participants, 104 took part in the UK, 75 in Dubai; 98 were male, 81 female. The average age of participants was 21, standard deviation 3.4.

The world's server was used to record a range of telemetering information in log files, which were later processed to extract the dataset. The dataset was made up of pairs of avatars, where Avatar 1 invited Avatar 2 to be a friend or accepted a friendship offer from Avatar 2, and pairs where Avatar 1 did not invite Avatar 2 to be a friend or did not respond to an offer of friendship from Avatar 2. Note that avatars had the opportunity to make friends only with the others in their session, meaning the dataset contains 1806 pairs and not all 31,862 possible permutations. In 624 of the pairs, friendships formed; in 1182 they did not. The data are carefully explained in Table 1. The metrics that we extracted from the server logs are explained next.

Table 1: Illustration of the Dataset

Avatar 1	Avatar 2	Friendship	Avatar 1 metrics	Avatar 2 metrics
AA	BB	1	…	…
BB	AA	1	…	…
AA	CC	1	…	…
CC	AA	0	…	…
AA	DD	0	…	...

Avatar AA asked BB to be a friend (Row 1) and BB agreed (Row 2). AA asked CC to be a friend (Row 3) but CC did not agree (Row 4). AA did not ask DD to be a friend (Row 5). All other possible combinations of avatar pairs would appear in later rows. Avatar metrics are explained in Section V.

IV. EXTRACTED METRICS

In this section, variable names are highlighted in italics. Our dependent variable, *friendship*, is coded as 1 if a participant invites another participant to become friends or accepts an offer of friendship from another participant, and 0 if a participant does not invite another participant to become friends or declines an offer of friendship from another participant. The variable captures a desire to form friendship and, as explained in Table 1, can be used to identify full friendship, unrequited friendship, and when no desire to form friendship exists.

Data on three aspects of avatar interaction were extracted: avatar appearance, avatar location, and avatar communication. For avatar appearance, users could customise the gender, clothing, hairstyle, hair colour, and skin colour of their avatars, and we extracted a metric for each. For avatar location we extracted a proximity metric to measure the average distance that each avatar stayed to the next closest avatar. For avatar communication, we extracted a metric for how much the avatar "talked." These metrics were created from the server logs for Avatar 1 and Avatar 2 (see Table 1) and were coded as follows:

Avatar *gender* was coded as male (1) and female (0).

Clothing options were coded as one of three classifications for avatar: *top* (from the waist up) and *bottom* (from the waist down). The three classifications represented the amount of skin the clothing revealed and formed an ordinal scale from mostly skin (1) to medium skin (2) to covered (3). Illustrations of each are shown in Figure 3. Amount of skin revealed was chosen as the salient measure of clothing style following previous research [Grammer, Renninger and Fischer, 2004; Abbey, Cozzarelli, McLaughlin and Harnish, 1987; Rosenfeld and Plax, 1977]. It is not the only

way clothing options could have been coded, but it is universally meaningful, unlike certain fashions that mean something particular to certain groups (such as a Gothick's attitude to black clothing, or a gang member's attitude to prison-issue baggy jeans).

Hairstyle was coded on the ordinal scale short (1), medium length (2), and long (3). Hair colour was coded on the following nominal scale: black, grey, red, brown, blonde, and unnatural (blue, pink, green, etc.)

Participants could choose to include *tattoos*. This was coded 1 for one or more tattoos and 0 for no tattoos.

Users had nine choices of *skin colour* for their avatars. These represent ordinal data and were merged into two categories: pale (1) and dark (2).

The classification of avatar options just described was done independently by two observers (one of the authors and another individual not involved in the research). In each case there was perfect agreement except for three of the male hairstyle options, indicating excellent overall inter-rater agreement. The three male hairstyle options were later discussed, after which agreement was reached.

For *proximity* we extracted the average distance that an avatar stood from the next closest avatar during their interaction in the virtual Times Square. Distance was measured using the world's *xyz* coordinate system.

For communication, a metric was designed to capture how talkative the avatar was. Total messages sent is one potential measure of this, but the problem with this is that Avatar 1 would not know the total number of messages Avatar 2 would send in the entire session when he or she was invited to be friends, and therefore it could not directly influence the friendship. Instead the average number of words per message was used and the resulting variables were labelled *words*. Note that "message" is defined as the text that is sent when the user types and then presses the enter key.

We also controlled for the gender of the user of Avatar 1 with the variable *AV1 user gender*: male (1) and female (0); the *location* where the study took place: UK (1) and Dubai (0); and whether the user of Avatar 1 was an experienced gamer using a three-level ordinal variable: non-gamer (0), gamer (1), and frequent gamer (2). This was self reported by participants by answering the following two closed questions: Do you play video games? and Do you consider yourself a gamer (someone who plays video games frequently)? The resulting variable was labelled *AV1 Gamer Experience*. Gender and game experience of the user of Avatar 2 were not controlled for, as these characteristics were unknown to Avatar 1 and therefore could not affect whether Avatar 1 made friends with Avatar 2.

How these metrics were used in analyses, and the results obtained, are presented next.

Figure 3. Illustrations of the Three Classifications of Avatar Clothing[1]

V. ANALYSES AND RESULTS

This section presents four sets of analyses consisting of one regression analysis of the data explained in Table 1 plus three robustness checks of the results obtained. The robustness checks were performed at different units of analysis, but all confirm the main finding of the original regression.

[1] The upper two avatars are revealing mostly skin, the middle two avatars are medium, and the lower two avatars are covered.

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First we ran a logistic regression on the binary dependent variable *friendship* to discover which if any of the variables described in Section IV determined whether friendship formed. The results are shown in Table 2. Of the avatar design variables (*gender match, clothing match (top), clothing match (bottom), tattoo match, skin colour match, hair colour match*, and *hairstyle match*), only two have a significant relationship with friendship: choice of clothing top and choice of clothing bottom.

The coefficient of both these variables is negative, which suggests that avatars scoring low on the clothing scale tended to form friendships with avatars that scored high on the same scale. In other words, avatars tended to make friends with avatars that were dressed differently from them, which is evidence of heterophily.

The other avatar design variables—skin and hair colour, hairstyle, and the presence of tattoos—were not related to whether friendships formed, meaning we did not find any evidence of homophily.

Result 1

Avatars did not tend to form friendships with avatars with whom they are similar in appearance.

Result 2

Avatars did tend to form friendships with avatars who dressed differently from them.

Table 2: Results of the Logistic Regression on *Friendship*

	Coefficient	Std Error	z value	Pr(>|z|)
Gender match	-0.0897	0.1293	-0.69	0.4880
Clothing match (top)	-0.2244	0.1247	-1.80	0.0718 .
Clothing match (bottom)	-0.3023	0.1247	-2.42	0.0154 *
Tattoo match	0.1596	0.1200	1.33	0.1836
Skin colour match	-0.0170	0.1212	-0.14	0.8886
Hair colour match	0.0452	0.1308	0.35	0.7296
Hairstyle match	0.2058	0.1295	1.59	0.1121
AV1 proximity	0.0000	0.0000	-0.60	0.5474
AV2 proximity	-0.0001	0.0000	-2.43	0.0151 *
AV1 words	-0.6371	0.2011	-3.17	0.0015 **
AV2 words	-0.5030	0.1975	-2.55	0.0109 *
AV1 user gender	0.5400	0.1300	4.15	0.0000 ****
Location	0.7606	0.1295	5.87	0.0000 ****
AV1 gamer experience	-0.1155	0.0814	-1.42	0.1560

AV1 and AV2 refer to Avatar 1 and Avatar 2. For the analysis, avatar gender, clothing, hairstyle, haircolour, tattoos, and skin colour variables were operationalised as dummy variables equalling 1 when the variable matched for Avatar 1 and Avatar 2, and 0 when they did not match. Significance codes: **** 0, ***, 0.001, ** 0.01, * 0.05, . 0.1; pseudo R^2 = 0.32. A full explanation of the variables is given in Section IV.

The finding on clothing heterophily was analysed again using three robustness checks. To start, the regression analysis was repeated using a mixed model. This was done because the rows in the dataset described in Table 1 are not strictly independent of each other and therefore break an assumption of logit regression [Koop, 2007]. A mixed model overcomes this problem by clustering the data in a way that maintains independence—in this case clustering by Avatar 1. The results are shown in Table 3 and support those of the first model: choice of clothing top and bottom are still significantly negatively related to friendship.

Table 3: Results of the Mixed Model

	Coefficient	Std Error	z value	Pr(>|z|)
Gender match	0.0868	0.1228	0.707	0.4795
Clothing match (top)	-0.3407	0.1235	-2.758	0.0058 **
Clothing match (bottom)	-0.2127	0.1242	-1.712	0.0869 .
Tattoo match	0.1377	0.1179	1.168	0.2426
Skin colour match	-0.1212	0.1191	-1.018	0.3088

Hair colour match	-0.0719	0.1297	-0.554	0.5794
Hairstyle match	0.1157	0.1232	0.939	0.3478

Results of the mixed model; number of obs: 1806, grouped by: AV1 (n=179); Random effects: AV1PlayerID var=0.26430, stdev= 0.51411; Significance codes: **** 0, ***, 0.001, ** 0.01, * 0.05, . 0.1; A full explanation of the variables is given in Section V.

The logistic regression and mixed model regression were performed at the relationship level. The second robustness check was performed at the person level; that is, we analysed the behaviour of each individual avatar as opposed to analysing relationships between two avatars. To do this, the data were reformatted to allow for matched pair t-tests to test for a difference between the proportion of an avatar's friends who dressed the same as the avatar, and the proportion of non-friends who dressed the same as the avatar. Specifically, two t-tests were performed on (1) the proportion of friends with clothing top matches and the proportion of non-friends with clothing top matches and (2) the proportion of friends with clothing bottom matches and the proportion of non-friends with clothing bottom matches. Note that "friends" were those who an avatar invited to be friends or who accepted friend invitations, and "non-friends" were others from the same data collection session. These tests will have less statistical power than the logistic regression will, but results still showed that there was a very significant difference among friend and non-friend clothing tops (p=0.0008) and a less-pronounced difference among clothing bottoms (p=0.107). In each case there was a higher proportion of matches with non-friends than with friends, which again supports our clothing heterophily finding. (To explain this result: if from a random selection of people an individual non-randomly chooses friends, and clothing has no impact, we would expect the t-tests to show no significant difference. If, as we found, there is a significant difference, then clothing does matter, and the fact that more non-friends were dressed the same than friends points to heterophily.)

As a final step, a traditional social network analysis was performed at the session level; that is, we analysed the data generated from each data-collection session separately. Graph theory, or network theory, is the branch of mathematics that developed to analyse networks. Graph theorists have created an "assortativity coefficient," which is a measure of the extent to which "like is connected to like" in a network [Newman, 2010]. The assortativity coefficient is therefore a measure of homophily/heterophily. The assortativity coefficient of the network graph of each session was calculated on the avatar clothing variables and was found to be significant (around -0.1 across the sessions). This again supports our main finding.

In addition to the above, the finding held when the analysis was repeated separately for the UK and Dubai data. Taken together, the models give confidence in the reported finding: avatar characteristics do not exhibit homophily, and avatar clothing exhibits heterophily.

Referring again to the results reported in Table 2, the logistic regression also suggests that proximity and talkativeness affect the likelihood of a friendship request. The amount of walking around the mixer space does not appear to influence friendship, but how close Avatar 2 stays to other avatars does. Based on theories of propinquity, we suggest that this is because being proximate encourages opportunities for interaction, which in turn leads to friendship requests. If all else is held constant, for each change of one unit of proximity, the average change in the mean number of friend invitations is 0.0001. (This seems like an extremely small effect, but the unit used to capture proximity is measured to an extremely small scale, best thought of as a "virtual centimetre." How this is actually calculated is quite complicated and uses a concept developed to create 3D computer graphics, but it can be thought of as a perceived distance: the length of one centimetre from the perspective of an avatar. For example, the avatars in the foreground of Figure 1 appear to be about 100 centimetres away from each other. While this is subjective to the user, it is not subjective to the virtual world, and the distance between the two avatars is known precisely.)

The results on proximity taken together are consistent with the following behaviour: avatars tend not to approach other avatars to invite them to be friends but instead make friends with those around them.

Result 3

The closer an avatar stands to others, the more likely he or she is to receive a friend invite.

Again as seen in Table 2, text communication is clearly a strong determinant of friendship. Further research is needed in this area, particularly qualitative research into the content of the chat and its impact on friendship. In this paper, we look at the amount of communication only quantitatively, specifically the number of words included in each message sent. If all else is held constant, for each additional word spoken per message, the average change in the mean number of friendship invitations is reduced by 0.6, and the average change in the mean number of friendship invitations accepted is reduced by 0.5.

Result 4

The fewer words an avatar uses, the more likely that he or she receives a friend request; avatars that use fewer words are also more likely to invite others to be their friends.

In addition, holding all else constant, males were more likely to make an additional 0.5 friend requests than females were, and UK participants were more likely to make at least one more friend requests than those in Dubai were.

VI. DISCUSSION

The goal of this paper was to examine the determinants of friendship in virtual worlds where the users involved are unaware of each other's real identities. This section discusses our work, explaining the results and their implications, alongside a critical examination of limitations and an outline for further research.

Overview

The friendships that formed in this project were not coerced or incentivised. Participants were not told or guided to make friends with each other, and all friendships that formed did so naturally. Results are based on a good sample size (n=179) and are backed up by four statistical tests: a regression model plus three robustness checks. Each check has a different unit of analysis (the relationship level, the avatar level, and the session level, as explained in Section VI), and all support our main finding. The data used were more detailed than would normally be available to social scientists studying relationships, as they include not only data on friendships that formed but also data on friendships that did not form. The also included information on unrequited friendships where one participant invited another to be a friend but the invitation was not accepted. Our results should therefore be statistically stronger than in studies where only information on friendships that formed is available.

The results are (1) that avatar friendships are not homophilious: avatars do not form friendships with other avatars that they are similar in appearance to; (2) that avatar friendships exhibit some heterophily: avatars tend to form friendships with avatars that are dressed differently; 3) the closer an avatar stands to others, the more likely that avatar is to receive a friend invitation; and 4) the fewer words an avatar uses increases the likelihood that he or she will receive a friend request, and avatars that use fewer words are also more likely to invite others to be their friends.

Homophily and Heterophily

We observed some evidence of heterophily but not homophily. This is consistent with previous research into virtual world friendship [Rauh, Polonsky and Buck, 2004; Donath, 2007; Nowak and Rauh, 2006], which has shown that avatar appearance—notably avatar clothing—has a significant impact on relationships. In particular, past work [Banakou, 2010] has suggested that the amount of skin revealed by an avatar has an impact by increasing the number of social encounters avatars experience, which is in line with what we found. Computer-mediated communication research offers a potential explanation: users often experience reduced social inhibition when interacting online [Kiesler et al., 1984; Walther, 1996], and this effect can lead to heterophily [Kobayashi, 2010]. In line with this, our findings suggest that reduced inhibition afforded by avatar interaction has the effect of a social lubricant, meaning that users are more likely to have social encounters with someone who is different from them.

That we did not observe homophily is in accordance with Ingram and Morris [2007], who studied a similar social mixer context, albeit one in the real world. They used sociometric badges, which record movement around a space to track MBA students at a social mixer, and found no evidence of homophily in the average encounter. Homophily may arise by personal choice, by social influence where two users influence each other to change over time, or by structures that push people together [Byrne, 1971; Turner, 1987; Ingram and Morris, 2007; Easley and Kleinberg, 2010]. As our sessions were not long enough to allow social influence to occur, and since our world did not feature structures that would have encouraged homophily, the only possible mechanism through which homophily could have arisen was personal choice, and we conclude that the participants did not choose to form relationships with similar others.(An example of what a structure that could push similar people together might be: if our world had an area that tended to appeal to a particular gender, such as a car showroom, we might expect this to discourage mixing among males and females.)

Proximity

The existing literature on virtual-world interaction suggests that the proximity avatars keep from each other is not arbitrary [Bailenson et al., 2003; Nassiri et al., 2004; Wilcox et al., 2006], and our findings are in agreement with this. Those avatars who stayed close to others tended to receive more friendship requests. However, how close an avatar kept to others had no impact on whether that avatar made a friendship request. Research into real-world relationships shows that being proximate encourages opportunities for interaction, which leads to friendship requests [Rivera et al., 2010]. Our results suggest that a similar effect is at work in virtual-world relationships, which lack the

time invested in the context of living close to others. Taken together, our results on proximity are consistent with the following behaviour: avatars tend not to approach other avatars to invite them to be friends but instead make friends with those around them.

Talkativeness

Our results suggest that avatars who communicate less are more likely to receive friend requests, which goes against findings on real-world relationships [Hruschka, 2010]. However, it is known that avatar friendship is different from both real-world friendship and relationships in other forms of online communication such as a chat room or forum [Munn, 2012; Dreyfus, 2004; Barney, 2004; Borgmann, 2004]. Unlike real-world friends, virtual-world friends have no possibility of non-voluntary disclosure, as users are in total control of their online presentation: there is no possibility of an avatar blushing or yawning or laughing inappropriately. An avatar will perform such actions only when the user gives a command to present these behaviours. Unlike relationships that form in online chat rooms, virtual-world relationships involve shared activity. Avatars can, for example, explore together, build virtual objects together, or sit on the beach together. Comparing our findings with findings from the context of other forms of online communication suggests that these shared activities may be more important than text-chat in attracting virtual-world friends, and this has implications on what it means to be a virtual-world friend.

Our results also suggest that avatars who use fewer words are more likely to invite others to be their friends, which is consistent with existing findings (see, for example, Walther [1992]). We suggest that this is a function of the time it takes to chat in a virtual world, where every word must be typed. Those who type less, and therefore chat less, have more time to make friend requests. Currently there is little work in this area, and future research should examine the impact of text-chat on virtual world relationships further and look to develop theory on this.

Conclusion and Contribution

This paper has examined avatar relationships in social networking virtual worlds. Such relationships do not exhibit homophily, at least in the absence of structures that push similar avatars together. In addition, the anonymity provided to a user by his or her avatar reduces social inhibition, allowing dissimilar avatars to mix. Avatar proximity has an impact on the likelihood of friendships forming by creating opportunities for interaction. Text-chat also has an impact, but this has not yet been fully explained or theorised.

Our findings on homophily and heterophily are important as they contribute to a debate on how both emerge, and we highlight potential value in the long-term study of these concepts. While we did not observe homophily in our sessions, were it to emerge over a longer term, the data collection approach used here could give great insights into the processes involved. In addition, given the ease and low cost of virtual-world design, an experimental protocol could be used. For instance, to collect empirical data to test two competing theories on the emergence of homophily, say, comparing individual choice versus the existence of structures that encourage groups of similar individuals to form, researchers could create two virtual worlds and introduce structures into one of them—structures that existing literature suggests create ingroups and outgroups—and compare the relationships formed in each. This would be difficult and costly to do in a real-world study, but we have demonstrated that it is neither difficult nor costly to do in a virtual world. This highlights a real strength of a virtual-world research method.

Something similar could be done to aid theorising on the emergence of heterophily, which, as Benediktsson [2012] says, is held back by a lack of data. Using virtual-world data in this way is referred to by virtual-world researchers as *mapping* virtual data to real-world problems [Williams, 2010].

The paper's contribution is twofold. First, we have shown the determinants of virtual world friendship, which contributes to both virtual-world theory and to the theories of homophily and propinquity. In addition, knowledge on the determinants of virtual-world friendship will be useful to the development of theory on virtual-world governance and information diffusion through virtual worlds, which have so far been under-researched. Second, we have demonstrated the value of virtual-world server logs to IS research, and suggest that the protocol we use here could also be useful to social scientists in a range of disciplines working on a number of problems that are difficult to study in the real world.

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